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MONTHLY REPORT - SEPTEMBER 1978

RESEARCH HIGHLIGHTS

	Page
Third North Pacific Albacore Workshop Held in Honolulu	1
Second Cooperative Survey Cruise to the Northwest Hawaiian Islands Completed	3
Albacore Injected with Tetracycline in Age Determination Study	6
Environmental Conditions in Eastern North Pacific Described.	7
Larval Anchovy Found to be Highly Sensitive to UV-B Radiation.	8
Swimming of Larval Anchovy Analyzed Mathematically	10
White Sea Bass Larva Identified.	11
Results of 1978 Hake Spawning Biomass Survey Summarized.	12
Scientists Present Tuna Research Results at ICCAT	15
Sampling Continues of US Tuna Purse Seiners in Puerto Rico	18
Biological Sampling of Foreign Imports of Atlantic Tunas Continues in Puerto Rico	19
Cooperative Swordfish Tagging Program Begins	20
Dedicated Vessel <u>Queen Mary</u> Completes Fourth Cruise.	22
Data Collected from Adult Striped Bass	29
NOAA Administrators Visit La Jolla Laboratory.	31

TO OUR READERS:

In the future, to cancel delivery of the Southwest Fisheries Center (SWFC) Monthly Report, or to change the delivery address, please notify by writing, Editor, Southwest Fisheries Center, P.O. Box 271, La Jolla, California 92038.

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SOUTHWEST FISHERIES CENTER
LA JOLLA, CALIFORNIA

HONOLULU LABORATORY
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PACIFIC ENVIRONMENTAL GROUP

MONTHLY REPORT - SEPTEMBER 1978

STATUS OF PUBLICATIONS

Approved by Center Director

Bartoo, Norman W. An examination of the harvest status of South Atlantic albacore (Thunnus alalunga). For publication in the Fishery Bulletin, U.S.

Chess, James R. Some procedures for assessing organisms associated with rocky substrata. For publication in Proc. 2nd Pacific Northwest Technical Workshop.

Mendelssohn, Roy. The effects of grid size and approximation techniques on the solutions of Markov decision problems. Improved bounds for aggregated linear programs. For publication in Operations Research.

HONOLULU LABORATORY

RESOURCE ASSESSMENT AND DEVELOPMENT INVESTIGATIONS (RADI)

Third North Pacific Albacore Workshop
Held in Honolulu

The third North Pacific Albacore Workshop was convened at the Honolulu Laboratory on September 13 and 14, bringing together albacore biologists and population analysts from the Southwest Fisheries Center (SWFC), Japan, Oregon, California, Washington, and Canada. The workshop

This report does not constitute publication and is for information only.

was chaired by Dr. Jerry A. Wetherall, Leader of the Fishery Management Research Task, and focused on: (1) a review of the North Pacific albacore fisheries during 1977 and 1978, (2) an exchange of fishery data and updating of basic statistical tables, and (3) a discussion on several working papers dealing with albacore stock assessment, fishery oceanography, and biology.

In evaluating the status of the North Pacific albacore stock, the group judged that present fishing effort was somewhat less than the level producing maximum sustainable yield (MSY), but expressed concern over the increased concentration of effort on 2-year and 3-year-old fish in the Japanese pole-and-line fishery. The record low catches during 1977 in both the United States and Japanese pole-and-line season were attributed to a variety of factors. While weak frontal structure was thought to be the principal cause of poor fishing, a drop in recruitment could not be ruled out. Cohort analyses have shown a fourfold to fivefold variation in year-class strength.



Participants in the third North Pacific Albacore Workshop were (from left to right): Richard Shomura, Director of the Honolulu Laboratory; Sigeiti Hayasi, Tohoku Regional Fisheries Research Laboratory, Shiogama-shi, Miyagi ken, Japan; Marian Yong, Honolulu Laboratory; Larry Hreha, Oregon Department of Fish and Wildlife; Mark Pederson, Washington Department of Fisheries; Toshio Shiohama, Far Seas Fisheries Research Laboratory, Shimizu, Shizuoka ken, Japan; Norman Bartoo, La Jolla Laboratory; Fred Hagerman, California Department of Fish and Game; Gary Sakagawa, La Jolla Laboratory; Jerry Wetherall, Honolulu Laboratory; Mike Laurs, La Jolla Laboratory; and Keith Ketchen, Fisheries Environment Canada, Pacific Biological Station, Nanaimo, B.C.

Second Cooperative Survey Cruise to the Northwest Hawaiian Islands Completed

The Townsend Cromwell returned to Honolulu on September 24 after completing cruise 78-03 to assess the nearshore and offshore fishery resources, birds, and marine mammals in the Northwestern Hawaiian Islands (NWHI). This was the second cooperative cruise completed under the provisions of the Tripartite Cooperative Agreement involving the Honolulu Laboratory, the Hawaii Division of Fish and Game, and the U.S. Fish and Wildlife Service.

James H. Uchiyama, Chief Scientist on the cruise, reported that the survey covered many areas that had not been investigated on previous NWHI cruises. A promising area for spiny lobster, Panulirus marginatus, was discovered along the western edge of Gardner Pinnacles where relatively high catch rates were obtained. Uchiyama also reported that the North-eastern trawl catches at Hancock Seamounts consisted mostly of juvenile alfonso, Beryx splendens, and John dory, Zeus nebulosa, and that trolling and handlining produced relatively good catches of tunas, snappers, and groupers. Also of interest was the capture of the early juvenile stages of spiny lobster and slipper lobster, Scyllarides squammosus, at a night-light station occupied over the bank at Kure Island. Other members of the scientific field party were Fishery Biologist Fletcher V. Riggs, Research Assistants Victor A. Honda, Glenn R. Higashi, and Bert Kikkawa, and Cooperating Scientist Alan Solonsky of the University of Hawaii Marine Options Program.

Processing of Northwestern Hawaiian Islands Data Continues

Personnel in the Insular Resources Task at the Honolulu Laboratory continued work processing biological samples and data collected on cruises to the NWHI. Darryl Tagami, Research Assistant, continued work on various aspects of the life history of the red snapper, Etelis marshi, including the processing of otoliths for aging studies and livers and gonads for hepato-somatic and gonado-somatic indices.

Paul Shiota, Research Assistant, volumized plankton samples and, in conjunction with the Sea Grant project on spiny lobsters, fabricated Witham collectors which are used to sample postlarval spiny lobsters. Witham collectors will be tested at selected sites around the NWHI in attempts to capture the puerulus of spiny lobsters.

Robert Moffitt, Research Assistant, identified fish caught in bottom trawls, fish traps and on handlines; Jeffrey Sampaga, Research Assistant, read otoliths of amberjack, Seriola dumerilii, and armorhead, Pentaceros richardsoni; Robert Humphreys, Research Assistant, summarized catch and effort statistics on the NWHI spiny lobsters for the use of Dr. Tim Smith, Chairman of the Spiny Lobster Planning Team.

Data Coding for Ciguatera Project Prepared

Richard Uchida, Leader, Insular Resources Task, aided by Lucille Tsukano, Computer Technician, prepared a data coding format and codes for the ciguatera project. This included identifying and coding all the islands, atolls, submerged reefs, banks, and seamounts within the U.S. fishery conservation zone around Hawaii, Guam, and the Northern Mariana Islands. Sally Kuba, Computer Programmer, also assisted Uchida by obtaining a computer listing of the TC-78-01 ciguatera data for cooperating scientist Dr. Y. Hokama, Pathologist at the University of Hawaii John A. Burns School of Medicine.

Uchida also spent some time revising his manuscript, "Synopsis of biological data on frigate mackerels, genus Auxis."

Estimated Skipjack Tuna Landings Continue Below Long-Term Average

The September 1978 Hawaii landings of skipjack tuna were estimated at 127 metric tons (MT), which is 147 MT below the landings for the same period in 1977 and 265 MT below the 1948-77 long-term average for the same period. The cumulative landings from January through September were estimated at 2,451 MT, which is 641 MT below last year's landings for the same period and 1,294 MT below the 1948-77 long-term average for the same period.

FISH-ENVIRONMENT INVESTIGATIONS (FEI)

Hawaiian International Billfish Tournament Report Completed

Heeny Yuen, Leader, Recreational Fisheries Task, completed a report on the results of the Twentieth Hawaiian International Billfish Tournament (HIBT) which was held at Kailua-Kona, Hawaii from July 29 to August 5. The billfish catch set HIBT records for most blue marlin (105), most shortbill spearfish (9), and most total billfish (116). Areas which were within the influence of two experimental fish aggregating platforms installed by the Honolulu Laboratory earlier in the year were popular with the anglers. Forty-three percent of the billfish catch and 35% of the yellowfin tuna catch were made in these areas. Of the 26 available fishing areas of the tournament, these areas were 3 of the 9 most heavily fished ones. The diet of the blue marlin was more varied than usual and contained more opelu (Decapturus pinnulatus) than usual. Abnormal morphological conditions observed were two anal fins on a yellowfin tuna and a fist-sized tumor in a blue marlin stomach.

Tuna Behavior-Physiology Work Slows Owing to Lack of Fish

Dr. Andrew Dizon, Leader, Experimental Ecology of Tunas Task, reported that experimental work during the month was slow owing to a lack of test fish. Randolph Chang, Research Assistant, continued work determining active respiration rates of kawakawa, Euthynnus affinis, using the few fish available for experiments. Lead weights that were being used to weight the fish to make them swim faster have been replaced with tungsten rods, which are 80% denser than lead.

Dizon also reported that plans and equipment are being updated for future shoreside and field experiments. Lt. H. Jemison, the new NOAA Corps officer assigned to the Honolulu Laboratory, has assembled an electronics laboratory at Kewalo Basin that will be used to construct telemetry devices. He has devised an FM system to transmit and receive tail beat rate of free-swimming tuna. In addition, Dizon and Dr. John Bardach, cooperating scientist, have prepared a proposal for submission to the University of Hawaii Sea Grant Program to develop, deploy, and test attractant odor dispersion devices which may make the laboratory's fish aggregating buoys effective at distances greater than the visual range. The plans in the proposal call for solid slow-dissolving cakes impregnated with synthetic odors (or unimpregnated controls) to be placed at biweekly intervals on selected buoys.

A surplus military personnel boat was acquired to facilitate the field experiments. This 33 ft. fiberglass boat will be used for near-shore studies of buoy effectiveness and recruitment, ultrasonic tracking of free-swimming tunas and other related work.

Paper on Thermoregulation in Tuna Completed

Dr. Dizon and Richard Brill, University of Hawaii graduate student, completed a long review paper on physiological thermoregulation in tunas. This paper will be presented at the American Society of Zoologists meeting at the end of the year.

Sampling of Yellowfin Continues

Dr. Jean Cramer, under contract with Honolulu Laboratory to conduct a "burnt" tuna study, continued to collect blood and tissue samples from large yellowfin tuna. It is hoped that detailed analysis of key biochemical parameters will pinpoint the cause (and cure) of burnt tuna.

LA JOLLA LABORATORY

Coastal Fisheries Resources Division

ALBACORE FISHERIES PROGRAM

Albacore Injected with Tetracycline
in Age Determination Study

Dr. Michael Laurs, Leader of the Albacore Fisheries Program at the La Jolla Laboratory, is directing a special tagging study intended to determine the rate of layering in the otoliths of albacore so that the ages of individual fish can be accurately assessed.

The newly developed otolith-daily-ring method for aging fishes appears to be a powerful tool holding great potential for solving problems regarding age determination in albacore. Researchers using this method have assumed that there is a daily ring deposition on the otolith. Laurs' research will test this assumption.

Albacore are being tagged and injected with tetracycline, an osteophytic agent which is incorporated into bone and which will fluoresce when the bone is later viewed under ultraviolet light. Injecting a fish with tetracycline marks its otolith at the time of release. For recaptured fish, information on the time that the fish was at liberty can be used to determine the rate of ring formation and to test the assumption of daily ring deposition. Information gained from the tetracycline-marked otoliths may then be used for absolute age and growth determination, and possibly to test the assumption that a tagged fish's growth rate is unaltered by the presence of a tag or by the stress imposed in its application.

During the 1978 U.S. albacore fishing season--the second season of the tagging study--tagging and tetracycline injection operations were conducted on board the commercial albacore baitboat, Linda. The Linda was chartered by the American Fishermen's Research Foundation. Biological Technician Ronald Dotson and Biological Aid Stephanie Revesz of the La Jolla Laboratory conducted the tagging and injection operations. Records kept for tagged fish included tag number, date, location, fork length, sea surface temperature, and sometimes special remarks, e.g. the behavior or condition of the fish when returned to the water.

The Linda fished off of Baja California in late June through July. In August, the boat moved to central California waters until the end of the charter on September 20. During the charter, a total of 1900 albacore were tagged and released: 451 off of Baja; 1449 off of central California.

When possible, the Linda fished areas of small albacore so that returns were likely to be made over several years. When the boat fished on a mixed school including both large and small fish, only the smaller fish were tagged. Since few small fish were caught off of Baja California, large fish in the 74-83 cm size class were tagged at the onset of the season in June and July to provide information on within-season movement of albacore. Two separate groups of small albacore were tagged and released off of central California. The southern group, located around 35° north latitude and 123° west latitude and tagged during August, was composed primarily of 60-67 cm albacore. A second body of fish, made up of 52-58 cm albacore, was tagged in September at 36°20' north and 124° west. These small fish could return to the U.S. west coast over the next two or three years.

As of September 8, 1978, 42 tagged fish had been recaptured. In 36 cases, the otoliths and information on recapture date were available. Inter-American Tropical Tuna Commission scientists T. Foreman and A. Wild have examined otoliths of 19 of the recaptured fish using methods modified and developed by them for similar studies on yellowfin and skipjack tunas. Otoliths from two of the fish did not show any tetracycline mark, a situation which resulted from a defective tetracycline solution used to inject a small number of fish at the start of the experiment. The marks on the otoliths from the remaining 17 fish were clearly visible under UV illumination. They generally appeared as sharp, distinct, bright lines and usually were restricted to the width of a single ring on the otolith.

Laurs indicates that although conclusions should not be drawn from the experiment until additional data are available, preliminary results appear to show that: 1) there can be considerable variation in the time required to lay down a ring on the otolith; 2) the rings are not laid down more rapidly than one per day; and 3) in some cases, it is possible that one ring is laid down per day, but in most cases, it appears that formation of a ring takes more than one day.

Environmental Conditions in Eastern North Pacific Described

Ronald Lynn, Oceanographer at the La Jolla Laboratory, prepared figures and text as a contribution to a manuscript entitled, "Assessment of environmental conditions in the eastern North Pacific Ocean, January 1977 to March 1978." Lynn coauthored the manuscript with D. McLain of the Center's Pacific Environmental Group and F. Favorite of the Northwest and Alaska Fisheries Center.

The manuscript presents an overview of marine environmental conditions in the eastern North Pacific for this 15-month period, treating both oceanic scale events and regional coastal events and describing variations in marine climate, sea surface temperature, ocean surface

transport, upwelling, ice cover, and river discharge. The environmental variations are described with the intention of 1) aiding in understanding the relationship between events in the environment and changes in the biosphere, and 2) directing the scientific community to the available environmental records.

There were significant large-scale deviations from normal in the marine climate of the winters of 1976-77 and 1977-78. During both winters, the Aleutian low pressure cell was enlarged and depressed by 12 to 20 millibars and air circulation was enhanced. In the winter of 1976-77, a blocking pressure ridge over the Pacific Northwest helped to divert winds and storms toward the southern Alaskan coast where mild temperatures and abundant rainfall occurred. Drought occurred in California. In the winter of 1977-78, the storm tracks and winds had shifted eastward and record or near-record rainfall broke the California drought.

The Ekman surface transport calculated from wind stress acted to increase the North Pacific Current and the Alaskan Gyre. During the winter of 1977-78, there was strong onshore transport from Baja California to Alaska. This same result is seen in the upwelling index as computed by A. Bakum (PEG). Upwelling was weak or replaced by downwelling in both winters, but especially during the latter winter when some of the lowest values in the 32-year record occurred. Higher-than-normal temperatures prevailed along coastal regions of Baja California to Washington during both winters and they appear to correspond to the onshore surface transport and an increased Davidson Current.

LARVAL FISHES, COASTAL EASTERN PACIFIC PROGRAM

Larval Anchovy Found to be Highly Sensitive to UV-B Radiation

Dr. Hunter's group, under EPA contract, has been investigating the effects of UV-B, light between 285 and 320 nm., on the eggs and larvae of fishes. Experiments have established the UV-B dose-response relation for mortality, incidence of brain and eye lesions, and retardation of growth and development for the 4-day embryonic period of northern anchovy and Pacific mackerel. Hunter reports that during September, the group completed a series of laboratory experiments which extend their work beyond the 4-day embryonic period. Fifty percent of anchovy larvae survived a cumulative UV-B dose of $675 \text{ (J} \cdot \text{m}^{-2})_{\text{DNA eff.}}$ (95% confidence intervals, $595\text{--}767 \text{ (J} \cdot \text{m}^{-2})_{\text{DNA eff.}}$) over a 12-day period. This cumulative dose was nearly half that needed for a 50% mortality when the exposure was 4 days ($1150 \text{ (J} \cdot \text{m}^{-2})_{\text{DNA eff.}}$). The longer

the exposure to UV-B, the lower the total cumulative dosage necessary to produce the same mortality; direct reciprocity of cumulative dosage between a 4-day exposure and a 12-day exposure did not exist.

At all doses, survivors of a 12-day UV-B exposure grew more slowly than the controls; mean length at 12 days was inversely proportional to dosage. Surviving larvae had histological characteristics usually associated with the early stages of starvation, i.e., low zymogen levels in the pancreas and low glycogen in the liver. Only at the higher doses (dosage $1000 \text{ (J}\cdot\text{M}^{-2})_{\text{DNA eff.}}$) were brain lesions detected but the lesions were less well defined than in larvae exposed for 4 days at comparable doses.

In summary, extending the period of exposure from 4 to 12 days resulted in reducing the cumulative dosage for 50% survival by nearly a factor of two. This deviation from reciprocity may be related to the necessity for larvae at the end of the 4-day embryonic period to successfully initiate feeding. Larvae in the 4-day experiment showed a significant incidence of brain lesions even at the lowest dosage ($760 \text{ (J}\cdot\text{M}^{-2})_{\text{DNA eff.}}$), although 90% survived the 4-day exposure. It seems doubtful that any of these damaged larvae would be able to initiate feeding. That less than 50% survived such a dosage over 12 days supports this contention.

These data also suggest that UV-B treatment over 12 days affected the ability of larvae to capture sufficient numbers of prey even at the lower dosages. This is indicated by the retardation of growth in nearly all treatments and by the frequent occurrence of larvae with histological features associated with the first stages of starvation. This effect could be mediated by a direct damage to sensory or other systems required for capturing live prey or by such indirect effects as higher metabolic demand caused by the need to repair damage. Regardless of the mechanism, the probability of survival in the sea for such slow-growing larvae is low. Even robust larvae can withstand only a few days of starvation and the abundance of food in the sea is variable. In addition, slow growth results in a longer exposure to predators at a highly vulnerable size and hence reduces survival.

To relate the results of the 12-day exposure to UV-B under various ozone levels, experimental results are expressed as the daily UV-B dose (Setlow DNA weighted). Daily UV doses for various ozone levels are given for June, in our latitude, just below the surface of clear ocean water. These data are based on the findings of Smith and Baker (Visibility Lab, University of California San Diego).

Daily dose ($\text{J}\cdot\text{m}^{-2}$) DNA eff.	Event
44	Significant retardation of growth after <u>12 days</u> exposure at this daily dose
56	50% larvae die after <u>12 day</u> exposure at this daily dose
105	.32 cm ozone ("ambient")
141	.28 cm ozone (13% reduction)
190	.24 cm ozone (25% reduction)
288	50% anchovy die after a <u>4-day</u> exposure at this daily level
358	.16 cm ozone (50% reduction)

The above table indicates that most larval anchovy would die if they existed for 12 days in June just below the water surface in clear ocean water. Clearly, larval anchovy are highly sensitive to UV-B radiation. The computations of Smith and Baker indicate that in our latitude, in June, at present ozone levels, 50% of anchovy larvae would die if they existed for 12 days at a depth of about 4 m or less in the clear ocean water, and that 50% would die if they existed for the same period at a depth of about 0.8 m or less in the most turbid water studied. Lower ozone concentrations, of course, would increase the depth range over which this mortality would be affected and thus increase the proportion of the population damaged. Anchovy larvae occur throughout the upper mixed layer from the surface to the thermocline but the exact proportion of the population at a given depth is unknown.

Swimming of Larval Anchovy Analyzed Mathematically

Dr. Daniel Weihs, NOAA Post-Doctoral Research Fellow at the La Jolla Laboratory reported that he carried out an analysis of the swimming of larval anchovy to study the reasons for the bursts of continuous swimming observed in larvae of up to 4 days of age. Weihs defined a mathematical model of the swimming fish and showed that the bursts of continuous swimming typical of these yolk-sac larvae of northern anchovy (Engraulis mordax) are a means of reducing the energy required for swimming. He also showed that continuous swimming is the more efficient

form of locomotion for fish of this size. This situation changes as the larva grows out of the size range in which water viscosity is the dominant hydrodynamical factor. When the larva is over 5 mm long, intermittent swimming (beat and glide) gradually becomes more economical. The results of this study compare very well with observed behavioral changes.

Paper on California Current System Completed

Dr. Robert Owen, Oceanographer, has completed a paper entitled, "Free and stationary eddies of the California Current System" for publication by the University of California Press in Proceedings, The California Islands. In this paper Owen reviews ocean eddy systems in the California Current System (CCS) and presents new data on the Southern California Eddy and support for the hypothesis that CCS eddies may be comparable to coastal upwellings in their effect on nutrient enrichment of surface layers, an important ecological determinant.

MULTISPECIES TAXONOMY

White Sea Bass Larva Identified

This month, researchers of the Multispecies Taxonomy Program identified a larva of the white sea bass, an important recreational and commercial species. A single white sea bass was reared to the age of fin formation and its fin counts were matched with those of adults.

Earlier larval stages were found in CalCOFI plankton collections and two post-yolk-sac individuals were supplied by Mike Sowlby of Marine Biological Consultants, Costa Mesa.

The white sea bass larvae are unusual in having a huge head with intricate spination and large toothy jaws. Interestingly, a recent taxonomic revision of Indo-Pacific sciaenids removed this species from the genus Cynoscion. The larvae are very distinct from those of Cynoscion and support the new generic reassignment.

The white sea bass has steadily declined in abundance over the years. Now that its larvae can be identified from CalCOFI samples, considerable new information will be available on its early life history.

RECREATIONAL AND COMMERCIAL FISHERY RESEARCH FOR MANAGEMENT

Results of 1978 Hake Spawning Biomass Survey Summarized

Dr. Gary Stauffer, Fishery Biologist, provided the following summary of his examination of the 1978 hake survey of spawning biomass off California and Baja California.

The results of the 1978 egg and larva surveys described the temporal and geographic distribution of the hake spawning population. Spawning began in the coastal areas off central California in January. Spawning apparently peaked in March off central and southern California. Very little spawning was detected in May. The distribution of hake larvae in March suggested that 1) the northern limit of spawning was off San Francisco, 2) the spawning extended out approximately 160 nautical miles off central California, and 240 nautical miles off southern California, and 3) the southern limit of the population coincided approximately with the extended U.S.-Mexico border.

In the past, the center of the spawning has been observed to be further south. The more northerly distribution observed this year may be the result of a more migratory segment of the stock being fished out or warmer oceanographic conditions keeping the spawning population further north. Additional surveys in years of colder water conditions are needed to confirm which hypothesis is more correct.

Spawning hake population in 1978 appears to be on par with that in 1977. Data gathered by the 1976 U.S.-U.S.S.R. cooperative survey, conducted from mid-January to mid-February by the Soviet R/V Poseydon implied that the hake spawning area and spawning biomass were very much below normal; these conditions did not re-occur. The percent of positive stations in 1978 is approximately the same as 1977 and higher than 1972 and 1975 for the same regions and time period. The average standardized number of larvae per 10 m² for 1978 is somewhat greater than in 1977 but almost equal to 1972 and 1975 values. These averages, based on small sample sizes, can be greatly influenced by the occurrence of 1 or 2 large samples which is to some extent the case for the 1978 Jordan and Ogon surveys.

Rockfish Collected at Tanner Bank and San Clemente Island

A short cruise was made on the NOAA research vessel David Starr Jordan, September 6-8, 1978, to collect rockfish. Samples were taken by John MacGregor, Fishery Biologist, at Tanner Bank and from stations on the east side and north side of San Clemente Island. Of the ten species taken, kelp and whitebelly rockfish were taken only at east San Clemente Island. Treefish and gopher rockfish were taken only at

north San Clemente Island. Bocaccio and green spotted rockfish were taken only at Tanner Bank. Rosy, olive, blue and starry rockfish were taken both at north San Clemente Island and Tanner Bank.

For the more abundant rosy, olive, and blue rockfish, the average lengths were greater for fish from the Tanner Bank samples than from the San Clemente Island samples. This may indicate greater fishing pressure on the more available San Clemente Island populations of rockfish. However, the San Clemente Island rockfish were relatively fatter (higher K values) than similar species from Tanner Bank. The lower K values may reflect denser populations and relatively poorer feeding conditions on Tanner Bank.

Fatness in rockfish may result from adverse conditions. Some of the fattest rockfish that MacGregor has examined were taken in Santa Monica Bay several years ago. A composite sample of five of these very fat starry rockfish contained 2,600 parts per million total DDT in body cavity fat, 1,000 ppm in the liver and 57 ppm in the fillets. Apparently the fat accumulates in these fish because the very high concentrations of DDT stored in the fat interfered with the fishes fat metabolism. However, this is probably not a factor in rockfish taken from the offshore banks and islands where DDT concentrations in rockfish were very much lower than in fish taken close to the source of contamination.

Aerial Survey Data from Anchovy Fishery Analyzed

Computer programmer Joe Caruso has produced a summary analysis of anchovy sightings in the Los Angeles Bight. The distribution of all 14,890 anchovy sightings during the 1962-1977 periods can now be printed by computer. The 10-minute blocks with the most sightings (886 and 843 sightings) are in the Catalina Channel. The computer graphics output facilitated the stratification of anchovy sightings into the three main groups: 1) Port Hueneme/Santa Barbara area; 2) San Pedro area; and 3) the low abundance areas west and south of the other two sections.

Statistician Keith Parker utilized weekly anchovy reduction fishery landings data for 1965-1977 to further stratify the anchovy sightings into appropriate seasons. Each year was divided into 1) autumn fishing season, 2) winter break, 3) spring fishing season, and 4) non-fishing season. This work is preparatory to a proposed sighting power analysis which will aid the improvement of aerial survey abundance indices.

Spanish Delegation Visits Center

Dr. Gary Stauffer, Alec MacCall, Dr. Gary Sakagawa, Dr. Paul Smith and Dr. Reuben Lasker met with a Spanish fishery delegation in La Jolla on September 22. The delegation of four was headed by Dr. Enrique C. Lopez Veiga, who has worked in ICNAF and with scientists at NEFC, Woods

Hole. Veiga and his colleagues were interested in learning about fishery resources off our Pacific coast including status of stocks, fishing method, and fishery products, particularly for Pacific hake and Loligo squid.

During their stay the delegation came to an agreement with Director Barrett to initiate plans for a cooperative research survey for offshore Loligo squid in 1979. The Spaniards offered one of their commercial trawlers specialized in harvesting squid for a research vessel. The primary objective of such a survey would be to assess the relative magnitude of the resource and the availability of the resource to off-shore trawling methods.

The Spaniard's 10-day itinerary included stays at various west coast cities visiting fishery laboratories and fish processors to discuss Spanish participation in fishery research, commercial harvest, and exports of U.S. products to Spain.

Survey of Partyboat Recreational Fishermen Initiated

The southern and central California partyboat passenger survey got underway during September. Vessels from San Diego, Oceanside, and points north to Santa Barbara were surveyed during the last two weeks of September. Approximately 800 completed survey forms will be analyzed by the contractor, Center for Natural Areas, Inc., and a preliminary evaluation of the results will be made in November. Dr. Dan Huppert, leader of the Commercial and Recreational Fisheries Research for Management Program, and Economist Cynthia Thomson of the La Jolla Laboratory are working closely with the contractors and will be involved in the evaluation of the survey. If modifications to the survey instrument or survey procedure are needed, they will be made before the central California portion of the survey is begun this winter. The entire survey will be repeated twice more next spring and summer in order to ensure that a reasonable variety of conditions are sampled.

Jack Mackerel Plan Development Continues

Both biological and economics sections of the fishery plan are being developed. One interesting finding was that the larva densities in the CalCOFI region exhibit no trend in jack mackerel abundance since 1951. Economic examination focuses on fishing fleet characteristics, processing capacities, and allocation of landings to various end-products. The latter aspect of the fishery presents difficulties because mackerel that goes into pet food and fish meal is not reported regularly.

Industry Economist Jane McMillan has been collecting demographic information from Bureau of the Census publications and from local Chambers of Commerce. The value and applicability of this information to fisheries management will be examined in coming months.

Oceanic Fisheries Resources Division

TUNA RESOURCES PROGRAM

Scientists Present Tuna Research
Results at ICCAT

Scientists of the Tuna Resources Program have recently completed stock assessment analyses on Atlantic yellowfin, skipjack, bigeye tuna, and albacore. They will present the results of their work at the next meeting of the Standing Committee on Research and Statistics (SCRS) of the International Commission for the Conservation of Atlantic Tunas (ICCAT) to be held in Madrid, Spain, from November 8 to 15, 1978.

The Atlantic yellowfin-skipjack tuna fishery was examined, with particular emphasis on the American fishery, by Dr. G. Sakagawa, Leader of the Tuna Resources Program in La Jolla, A.L. Coan, Mathematician, and T.C. Murphy, Fishery Biologist. In their paper, "A Review of the yellowfin-skipjack tuna fishery of the Atlantic Ocean and American participation, 1965-75," they describe the tropical tuna fishery as the largest tuna fishery in that Atlantic, with approximately 174,000 metric tons of yellowfin and skipjack landed in 1975. The eastern tropical surface fishery for yellowfin tuna has grown since 1969, while longline catch has stabilized at about 30,000 metric tons. The skipjack tuna fishery, also primarily in the eastern tropical Atlantic, produced a record high catch of 114,700 metric tons in 1974, but declined sharply to 59,500 metric tons in 1975.

American participation in the Atlantic fishery began in 1967, grew rapidly in 1969 to 27 vessels, and peaked in 1972 with 36 vessels participating in the tuna fishery off Africa. In 1975, 32 American tuna seiners participated in the eastern Atlantic fishery and their total catch was 13,960 metric tons of yellowfin tuna and 7,370 metric tons of skipjack tuna. The authors conclude that both stocks appear to be in good condition. The yellowfin tuna stocks are capable of yielding larger catches, but probably at reduced catch-per-unit of effort, while future catches of skipjack tuna are expected to vary markedly, because the skipjack tuna fishery is dependent on one or two year classes and the amount of fishing effort is dependent on the availability and abundance of the co-target species, yellowfin tuna.

The status of the yellowfin tuna stocks was investigated by Coan and Dr. W. Fox, Leader of the Oceanic Fisheries Resources Division at the La Jolla Laboratory. In their paper, "A production model analysis of yellowfin tuna (*Thunnus albacares*) stocks in the Atlantic Ocean, 1964-1977," production model analyses were performed to determine how the status of stocks were affected by the expansion of the fishery into

a new offshore area in the eastern Atlantic Ocean. Large purse seiners, of carrying capacity greater than 450 metric tons, are the primary vessels involved in fishing this new offshore area. The authors approached the assessment for the eastern Atlantic surface fishery with two standardization of effort procedures. The result of production model analysis on data standardized without using the high catch rates of the large purse seiners gave an estimated maximum sustainable average yield (MSAY) of 116,000 metric tons. Their analysis with large purse seine data included in the standardization procedures resulted in a MSAY estimate of 143,100 metric tons. The authors concluded that the status of the Atlantic yellowfin tuna stocks, as judged only by production model analysis, appears to be more optimistic than in previous analyses owing to recent increases in yield from offshore expansion of the surface fishery. The authors note that any sustainable increases in catch are very uncertain and the fishery should continue to receive careful scrutiny.

Dr. N.W. Bartoo, Fishery Biologist, and Coan completed an analysis on "Changes in yield per recruit of yellowfin tuna (Thunnus albacares) under the ICCAT minimum size regulation," of 3.2 kg. The authors performed a cohort analysis on aged catch data to estimate the entire fishery equilibrium yield per recruit (Y/R) for the pre-regulation period, 1966-1972, and the post-regulation year, 1975. Recruitment to age I was estimated for birth years 1965 to 1975. Y/R isopleths calculated using this analysis indicated that longline fishery experienced a drop in equilibrium Y/R of 57% between the pre- and post-regulation periods. The purse seine fishery experienced an increase of 55% in equilibrium Y/R, due to increased catches of older fish. The baitboat fishery experienced a decline in equilibrium Y/R of 45%, due to decreased catches of older fish and increased catches of age I fish. The authors conclude that increasing fishing effort without changing size at recruitment or age structure of the catch will result in slight losses in Y/R to the purse seine and longline fishery. The baitboat fishery will realize slight Y/R gains by increasing fishing effort without changing size at recruitment. A generalization of the results of the recruitment estimates indicated that either recruitment has been increasing or that the 1965, 1967, and 1968 year classes were weaker than average. Current evidence suggests that the latter case is more likely.

Sakagawa and Coan examined the problem of misidentification of young yellowfin tuna and young bigeye tuna and produced a document entitled, "Adjusted catches of yellowfin and bigeye tunas for the 1976 Atlantic fishery." Young yellowfin tuna and bigeye tuna are very difficult to tell apart. The authors note that there is no economic incentive for fishermen or fishbrokers to separate the catches of these fish and to accurately record the catch statistics. This leads to inaccuracy in the catch statistics reported by the ICCAT. Sakagawa and Coan reviewed the misidentification problem and provided estimates of adjusted bigeye and yellowfin tuna catches for 1976, using species composition and/or length frequency data. In the authors' opinion, the best estimates are 12,100 metric tons for bigeye tuna and 93,300 metric tons for yellowfin tuna for the surface fishery. In contrast,

the reported surface fishery catch, according to official ICCAT statistics, is 12,800 metric tons for bigeye tuna and 92,800 metric tons for yellowfin tuna.

The "Effects of Atlantic yellowfin (Thunnus albacares) stock structure hypotheses on production model analysis" were examined by R.G. Rinaldo, Fishery Biologist, and Coan. They investigated six hypothetical stock structures: an eastern Atlantic stock, an inshore eastern Atlantic stock, a surface eastern Atlantic stock, a deep eastern Atlantic stock, and offshore eastern Atlantic stock, and a total Atlantic stock, using production model analysis for the yellowfin tuna fishery, 1964-76. In addition, they examined the effect of misidentified young yellowfin tuna-bigeye tuna in the catch statistics on production model analysis. The resulting maximum sustainable average yields for the best fitted production model ranged from 13,000 metric tons for the eastern Atlantic longline fishery to 142,300 metric tons for the total Atlantic fishery. Their results indicate that the effects of stock structure uncertainty appear to be minimal in most cases. Maximum sustainable average yield values were approximately 10% higher when yellowfin tuna landing data for 1964-1976 are adjusted for inaccurate reporting of bigeye tuna and yellowfin tuna.

The status of the south Atlantic albacore was examined by Dr. N.W. Bartoo. In his paper, "An examination of the harvest status of south Atlantic albacore," two production model analyses were performed to estimate maximum sustainable yield (MSY) of the stock using two treatments of the basic data: nominal annual effort with total catch, and effort standardized to Taiwanese catch rates with total catch. Although all data sets used with the production model indicated substantial increases in yield are available, the MSY indicated by the two analyses did not agree. This lack of agreement suggests that additional research on standardization should be done if catches begin to increase. The author also performed a cohort analysis on age composition data from the south Atlantic stock to produce an age-specific fishing mortality vector for use in estimating equilibrium yield per recruit (Y/R) to the fishery. The fishery is currently realizing a Y/R of about 7.65 kg. The analysis indicated that increases in effort, or size, at recruitment will produce only slight changes in the Y/R.

Bartoo also investigated the status of the north Atlantic albacore stock. In his paper, "The status of the north Atlantic albacore (Thunnus alalunga) stock," he used a cohort analysis to estimate recruitment to age I for the 1963 to 1971 cohorts. Recruitment estimates were quite insensitive to changes in fishing mortalities at older ages. Catch per effort of longline-caught albacore was used as a parent stock index to develop a spawner-recruit relation. The results show the current adult albacore population to be about 1/3 to 1/4 or less of its original size. A period of increased variation in recruitment from 1968 to 1974 corresponds to low parent stock abundances. The Y/R of the entire north Atlantic albacore fishery was estimated to be between 3.83 and 4.03 kg., depending on the assumed natural mortality rates.

At the current size of recruitment, a reduction in fishing effort of between 20% and 50% is required to maximize Y/R to the fishery. The actual realized gain in Y/R would be between 1% and 12% depending on natural mortality rates chosen.

Dr. Andrew Bakun of the Pacific Environmental Group at Monterey, California, has analyzed available data and presented a description of "Guinea Current upwelling" for submission to the ICCAT. He presents a comparison of summer-fall upwelling to July-October rainfall in Ghana and to the catch of the Ghanaian herring fishery. The author concludes coastal rainfall are associated with strong upwelling.

Sampling Continues of US Tuna Purse Seiners in Puerto Rico

Some purse seiners of the United States tuna fleet who traditionally fish in the eastern tropical Pacific during the first semester of the year participated in the tuna fishery off west Africa during the last semester. These vessels generally leave in late June or early July and return to unload their catches in Puerto Rico in October to December. Catches of these seiners have been sampled for length composition since 1967 by the La Jolla Laboratory through a contract with the Inter-American Tropical Tuna Commission.

The number of U.S. purse seiners fishing off west Africa increased from three in 1967 to a record high of 33 in 1972. In 1976, the number dropped to seven due to vessels remaining in the eastern tropical Pacific.

As of October 25, 1978, 19 U.S. vessels have participated this year in the fishery off west Africa. Estimated total catches of yellowfin, bigeye, and skipjack tunas is 18,547 metric tons. Five vessels have returned and their catches have been sampled for length composition. The results are shown in the following table.

	# of samples	# of fish
Yellowfin	13	596
Bigeye	4	53
Skipjack	10	428
Other	3	62
Total	30	1139

Three yellowfin and five skipjack samples are from catches in the Caribbean Sea. In general, two length groups are obvious in samples of yellowfin and bigeye tuna catches: fish between 45 and 190 cm. in fork length and fish between 130 and 160 cm. in fork length. The larger length group generally occurs in samples of catches made farther

offshore (i.e. outside the Gulf of Guinea area). Skipjack tuna in catches made in the Caribbean sea were larger (60 to 72 cm.) than skipjack tuna in catches off west Africa (40 to 60 cm.).

Biological Sampling of Foreign Imports of
Atlantic Tunas Continues in Puerto Rico

Atlantic-caught tunas transshipped to Puerto Rico have been sampled routinely for data on fork length, weight and species composition by Biological Technician Eugene Holzapfel of the La Jolla Laboratory since March 1975. Results of sampling during the period January through September 1978 are as follows:

Species	Gear	No. of Samples	No. of Fish Sampled	Tonnage Sampled (MT)
Yellowfin	Baitboat	26	1307	973
	Purse Seine	4	167	150
Skipjack	Baitboat	15	751	4146
	Purse Seine	4	202	2757
	Longline	1	50	5
Bigeye	Baitboat	21	904	431
	Purse Seine	4	130	227
Albacore	Longline	2	100	662
TOTAL		77	3611	9351

Number of Vessels Contributing Data
to FAX Advisory Program Increases

During September 1978, 26 tuna seiners and 3 research vessels contributed synoptic weather and expendable bathythermograph (XBT) data to the NMFS FAX Advisory Program. A total of 216 weather and 20 XBT observations were reported via NMFS-licensed radio station WWD. The chart below lists data pertaining to program participation during September 1975-1978. It shows that while the number of vessels with equipment has decreased since 1975, the number of vessels contributing data has increased. It also shows that the number of observations during September 1978 was higher than in past years.

	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
Number of vessels with equipment	74	65	61	50
Number of vessels reporting	19	19	17	29
Number of weather observations reported	122	154	146	216
Number of XBT observations reported	34	0	15	20
Monthly observation total	156	154	161	236

The leading participants in the program this month were Captain John Silveira and the crew of the tuna seiner Cheryl Marie, with 11 weather observations and 12 XBT observations. NMFS extends their thanks to these and all other contributing participants.

Cooperative Swordfish Tagging Program Begins

For many years, the National Marine Fisheries Service has encouraged marine anglers to tag and release marlin and sailfish in the Service's Cooperative Marine Game Fish Tagging Program. Recently, the Service, in cooperation with southern Californian marine game fish anglers, has initiated a harpoon tagging program for swordfish.

The swordfish harpoon fishery is primarily a commercial fishery with an annual catch of up to 6,000 swordfish. These fish have not been a target species for tagging because of their dollar value--prices have ranged from \$1.35 per pound to \$2.00 per pound; the average weight of a swordfish is about 200 pounds.

With the cooperation of Horace Witherspoon, International Game Fish Association trustee, and William Pigg, of Newport, California, big game fishermen are being encouraged to tag swordfish using a special harpoon, thus aiding the Service in developing additional life history information on swordfish in the eastern Pacific. The tagging gear, fabricated by Pigg, consists of a 16-foot fiberglass tagging pole and dart tags. The fiberglass tagging poles are manufactured by the Garcia Corporation, which donated a number of poles for development and testing and for initial distribution to cooperating anglers.

The program is intended to assist in determining the migratory patterns and rates for swordfish in the northeast Pacific on both a short-term and a long-term basis. Tagging may assist in determining

whether the swordfish range south toward the north equatorial area in winter and spring, as the timing of fisheries seems to indicate. High catch rates occur off the lower west coast of Baja California in the late fall and winter, followed by an increase in catch rate for the area 10° north in the spring, then by the development of the fishery off California in the late summer and fall.

Since September, over ten swordfish have been tagged and the first recovery by the commercial harpoon fleet has been reported.

Biological Technicians Collect Swordfish Data at Sea

The staff of the Oceanic Fisheries Resources Division at the La Jolla Laboratory is developing a complete data base and capability for periodic analysis of the state of swordfish stocks in the eastern Pacific Ocean, in support of the Fishery Management Plans. The California Department of Fish and Game is collecting fishing logs and catch data from the California harpoon swordfish fishery; this information is being placed in the data base. In addition, biological technicians are collecting data at sea on sex, gonad weight, total and dressed weights, and length measurement of various parts.

The long-range objectives of the at-sea data collection program are to: 1) develop identification procedures so that selected fishermen can collect sex data of fish that are headed and dressed at sea; and 2) obtain information on biological parameters and their seasonal changes for Pacific swordfish.

Four sampling trips, two to ten days in length, have been completed since the program began on August 25, 1978. Biological technicians Linn Shippley and Dimitry Abramenkoff were involved in the trips and collected data from about 83 swordfish. About 70% of the fish sampled were females; 30%, males. Commercial swordfishermen who have cooperated in the program are: Bud Sears of the vessel Invader, Elver Hehr of the Dorsal, Fred Happ of the El Gazelle, and John Larson of the Dor-Ann.

Dedicated Tuna Seiner, Queen Mary, Returns to San Diego after Completion of Cruise III

The tuna seiner, dedicated exclusively to research on the tuna/porpoise interaction by the industry for one year, returned to San Diego after completion of the second leg of Cruise III on August 18. The results of the olfactory lure experiment conducted by W. Ikehara of the University of Hawaii were not encouraging. Although some individual fish appeared to respond to the various lures, there was no reaction by the school as a whole. The behavioral work led by Karen

Pryor, an independent contractor and acknowledged expert on behavior of Stenalla, appears promising and there seem to be some indications that porpoise may not be as stressed during netting and after release as previously theorized.

While the Queen Mary was in port, tracking equipment for the radio tags to be used on Cruise IV were installed aboard the ship. The porpoise impoundment system was also tested and placed on board. Late in August the system was deployed locally to train personnel scheduled to participate on Cruise IV.

Conference on Age Determination in Marine Mammals Held in La Jolla

One hundred and twenty-five scientists from around the world gathered in La Jolla in early September for a three-day symposium on age determination in odontocete cetaceans, sponsored by the National Marine Fisheries Service, the International Whaling Commission, and the Marine Mammal Commission and organized by the SWFC's Marine Mammal Biology and Technology Program. Thirty-one experts in methods of age determination from 10 different countries attended an intensive, two-week workshop following the symposium at the SWFC. The workshop gave researchers an opportunity to share their knowledge of various techniques and to work side by side solving problems of mutual interest.

The discovery of two stranded cetaceans not far from the symposium site provided an unexpected addition to the conference. The two animals-- a common dolphin, Delphinus delphis, and a beaked whales of a yet-unnamed species of Mesoplodon, washed up at Carlsbad, California. A tooth of the beaked whale was analyzed in the workshop.

The proceedings of the symposium and a report on the workshop will be published in a volume entitled, "Growth of Dolphins, Porpoises, Toothed Whales, and Sirenians: Problems in Age Determination." The Book will be edited by Dr. W.F. Perrin and Dr. A.C. Myrick, Jr., and will be published by the International Whaling Commission.

MARINE MAMMAL ASSESSMENT AND MONITORING PROGRAM

Dedicated Vessel Queen Mary Completes Fourth Cruise

Cruise IV of the Dedicated Vessel M/V Queen Mary was completed on October 31. The objectives of the 50-day cruise to the eastern tropical Pacific were:

- 1) to study the age and sex structure of porpoise schools; 2) to evaluate operational feasibility of tagging operations of porpoise;
- 3) to investigate the degree of cohesion of schools for use in future

design of tagging experiments; 4) to inject tetracycline marks in porpoise with appropriate tags for aging calibration; 5) to obtain stomachs for comparative food habit studies of porpoise and tuna; 6) to examine organ systems of porpoise for potential pathology factors induced by chase and capture; 7) to obtain blood and frozen organs for use in capture myopathy studies; 8) to compare visual estimates of school size with actual censuses of individually examined animals; 9) to observe and measure the fishing operation and porpoise behavior for use in mortality reduction technology; and 10) to collect miscellaneous biological samples for use by other scientists.

To study and tag individual animals, the researchers, with the aid of the vessel crew, used a floating system of pens and chutes called a Porpoise School Impoundment System (PSIS). The PSIS is attached to the net so that when the vessel backs down, the porpoise swim over the corkloine into a corral. Two scientists or crewmembers swim in the corral with the porpoises and "cowboy" them into the chutes, where the animals can be measured, sexed, and tagged.

Approximately 40 days were spent on the fishing grounds. Twenty-one of the 40 days had weather which was suitable for PSIS deployment. During those 40 days 17 sets were made, 9 in which the PSIS was deployed and 8 in which gear observations were made (a waterhaul to test the PSIS was made prior to reaching the grounds). A total of 45 porpoise were killed during the cruise: 25 spotters, 17 eastern spinners, and 3 common dolphins. The average kill-per-set (excluding the test waterhaul) was 2.65. For gear sets the average was 1.13 and for PSIS sets it was 4.00.

A total of 842 animals were passed through the PSIS during the 9 sets, 812 spotters and 30 eastern spinners. These included 13 known recaptures from previous sets. Essentially all of these animals were sexed, classified to color phase (spotters only), and measured. Although no school was processed in its entirety (because either the entire school was not captured in the purse seine, or animals escaped from the PSIS during backdown), in several cases the general ages of escapees were noted and a school structure can be reconstructed. Additionally, the animals examined were from four disjoint geographical areas for further comparison.

Six hundred and fifty-six disc tags were placed on the porpoise in the nine PSIS sets. Two of these were removed upon recapture of the animals. The process of tagging took an average of 3 minutes per tag after a certain skill was acquired. This includes the time to deliver animals from the corral to the chutes; tag the animals, and release them. The effect of tagging on the animals during the operation and any lesions developed by recaptured animals were recorded photographically. Additionally, the scientific crew developed several ideas to modify the tagging apparatus and to improve the PSIS, both of which should increase tagging efficiency further.

Three reset sequences were initiated to study school cohesion, that is, the degree of immigration and emmigration between schools. A reset sequence began with the tagging of as many animals of a school as possible and the placement of a radio-pack on one or two animals so that the school could be tracked and a reset made. The cruise plans called for as many as two reset sequences with two or three resets, apiece. The first reset sequence was aborted after tracking the school for approximately 40 hours due to their inability to capture the target school and make a reset. The second initiated sequence terminated when the radio-pack of the tracked animal tore loose and the school could not be followed. The third reset sequence was successful in that: two resets were made and the animals were tracked for some 40 and 48 hours between sets. Another reset was not attempted due to: 1) the small number of recaptured tags in each reset, 2) the dwindling numbers in the school, and 3) the threat of impending bad weather.

The study indicates that the process of tagging acts essentially to randomize the marked sample within the population. Any estimates of migration rates between schools will have to be tempered by the small number of resets and recaptures. However, information gathered in the study will be useful in further experimental design. The recapture data not associated with the reset sequence may also prove useful. These data will allow an "order of magnitude" density estimate which will be useful in planning large-scale tagging. Additionally, the plotted movements of the tracked animals shed light on the speed with which the animals move and their behavior under these circumstances.

Review of Porpoise Assessment Surveys

The Marine Mammal Assessment and Monitoring Program hosted a meeting October 5 and 6 at the La Jolla Laboratory to review statistical methods of analyzing data collected on the 1977 Aerial/Ship Porpoise Population Assessment Survey and to discuss the objectives of the 1979 survey. Attending the meeting were Drs. D. Chapman and L. Eberhart, Marine Mammal Commission; D. Burdick, Living Marine Resources; D. Anderson and K. Burnham, Utah State University; R. Allen, Inter-American Tropical Tuna Commission; K. Pollock, University of California at Davis; and SWFC personnel. Among other things, the Committee decided to reduce the off coast coverage of the aircraft to allow more time on schools sighted. They also determined that at least 50% of the survey time will be spent calibrating the aircraft and two research vessels as observation platforms.

PACIFIC ENVIRONMENTAL GROUP

OCEAN CLIMATOLOGY AND MONITORING

Ship of Opportunity XBT Data Logger

Expendable bathythermographs (XBT's) are commonly used for quick, inexpensive measurements of subsurface ocean temperatures. Present XBT equipment is somewhat cumbersome because the data are recorded on an analog strip chart recorder. Use of an analog recorder degrades the precision of the data, results in inaccuracies of the radio message for real-time reporting of the data, and causes delays ashore for data digitization.

These problems are now being attacked in a cooperative effort with Oregon State University and Scripps Institution. Dr. Rod Mesecar of OSU's Department of Oceanography has developed an inexpensive XBT data logger that can interface directly to a standard XBT launcher and probe. This system uses an analog to digital converter and an inexpensive computer system to digitize and store the data on a tape cassette. The system is more accurate, more versatile, and costs less than a standard XBT recorder. It eliminates most of the present paper work involved in making an XBT observation and preparing a radio message. Ashore, the cassette tape can be rapidly input to a computer, avoiding present delays for data digitizing.

Tests of the unit were made this past summer aboard a Scripps vessel and recently by Kathy Setbacken of PEG aboard the Matson freighter, Hawaiian Queen. The Scripps test was successful but a hardware problem in the A/D converter caused failure of the Matson ship test. When this problem is resolved, the system will be installed operationally on the Hawaiian Queen. The system should allow us to maintain monitoring of ocean conditions between San Francisco and Honolulu at a relatively low cost. Scripps will install several of the units on merchant ships operating in the Equatorial Pacific.

TIBURON LABORATORY

FISH COMMUNITIES INVESTIGATION

Study Completed on the Adaptive Significance of Sexual Dimorphism in Four Species of Rockfish

The physical manifestations of sexual dimorphisms in animals are diverse, including brilliant color variations and modified appendages. The most common dimorphism, size variation, is not always obvious, but is just as important. In the rockfishes, the males and females do not appear to have any secondary sexual dimorphisms in body size, shape or color. A closer look does reveal that the growth rate differs between male and female and that many body parts are proportionally different.

Differences between the sexes and the factors influencing the evolution of these differences have been investigated for four species with similar habits: Sebastes mystinus, S. flavidus, S. serranoides and S. melanops. This work by Fishery Biologist Tina Echeverria is serving as the basis of an MS thesis at San Francisco State University.

In all four species, the females grow faster and reach a larger size than males of corresponding age (possibly as an adaptation to the extra weight and volume they incur while incubating the embryos). Males tend to have relatively larger body parts, with the pectoral rays and the width of the eye being larger in all four species. Since males and females aggregate together, body parts important in maneuverability and vision may enable the males to coexist with larger females.

Sexual selection alone cannot account for the sexual dimorphisms of rockfish, but reproductive and ecological pressures seem to have modified their body form.

Vast Food Resource for Nearshore Fishes Monitored

With the onset of the summer upwelling season at the Albion study site, vast numbers of caprellid and gammaridean amphipods appeared and literally carpeted the nearshore sea floor. Using an air-lift collecting device, Fishery Biologist Tony Chess measured densities of over 10,000 caprellids (mostly Metacaprella kennerleyi) and 108,000 gammarideans (mostly Jassa falcata and Microjassa claustris) in M² quadrates of the study site. Based on examination of their gut contents, these animals subsist largely on diatoms, which comprise most of the phytoplankton blooms so evident at this time of year. When present in large numbers, these organisms are the major foods of kelp greenlings and striped surfperch, both major recreational fishes in this region.

During the latter part of the summer, as upwelling and phytoplankton blooms diminished, the numbers of caprellids and gammarideans sharply declined. This month, Chess found that the caprellids occurred only in scattered patches, and the gammarideans had nearly disappeared. The impact of this decline on the fishes, if any, has not yet been determined.

FISHERIES DEVELOPMENT INVESTIGATION

Market for Rock Crab Tested

Rock crabs (Cancer anthonyi, C. productus, and C. antennarius) support a small but growing fishery in southern California. In central and northern California, the presence of dungeness crab has discouraged development of a fishery for rock crabs. A quick check with local markets, however, showed that a market for rock crabs exists, at least during the off-season for dungeness crab.

Teaming up with a local fisherman, Susumu Kato, Ed Ueber and Susan Smith of the Tiburon Laboratory participated in three fishing trips off Pt. Reyes to catch rock crabs with experimental traps. Catch rates averaged about eight pounds per trap in good areas. A market at Pt. Reyes and one in Chinatown, provided with rock crabs for test marketing, reported favorable results.

The fisherman who participated in the trips is presently awaiting approval of an experimental fishing permit from the California Fish and Game Commission since presently rock crabs cannot be legally taken by commercial fishermen north of Morro Bay. Further research into markets and gear for a rock crab fishery will be conducted by the Tiburon Laboratory once the fisherman obtains the required permit.

During the crab fishing trips we also tried but were unsuccessful in catching octopus with pots (clay pipes).

* * * * *

Kato traveled to Point Arena on September 29 to meet with potential suppliers, processors, and buyers of sea urchin roe. Although all parties agreed to try and develop an urchin operation at Pt. Arena, their efforts were later thwarted when local divers moved to Ft. Bragg to harvest urchins for a firm located there.

Ed Ueber traveled to Issaquah, Washington on September 20-22 to attend the annual workshop of the Western Association for the Valuation of Ecosystems. At the meeting Mr. Ueber was elected vice-president of the group of 65 working scientists from Alaska and Canada to Mexico. Ueber also traveled to Portland on September 26-27 to work on the Dungeness Crab Management Plan.

Tyee Club to Take Over Salmon Pen-Rearing Project

Thirteen silver salmon were captured in the gill net this month during regular semi-weekly sampling. None of the fish were marked, so it is not known from which of our previous releases the fish originated. The fish ranged from 1-3/4 to 5 lbs and so were probably from the two 1977 releases. Also, eight more king salmon tags from the laboratory's fall 1976 release were returned by anglers. The kings were caught in the ocean fishery near the Golden Gate.

Analysis of weight samples of the king salmon currently being reared indicated that growth during this month was somewhat less than the 30-day doubling rate reported initially. The fish now average 50 gm (9.1 fish per pound).

Several meetings were held with board members of the San Francisco Tyee Club regarding their take-over of the salmon pen-rearing project in the future. The Tyee Club has agreed to partially support the project next year by providing costs of feed, weekend labor and pen maintenance. The laboratory will provide for weekday labor and any research costs involved with next year's fish. We are planning an artificial imprinting study that will require 150,000 king salmon next year.

Stan Smith presented his Master's thesis on his work on the salmon project at San Francisco State University this month.

Anglers' Guide Publicity Effort Launched

This month, with the assistance of the National Fishery Education Center (F221) in Chicago, a campaign was launched to publicize the recently published Anglers' Guide to the United States Pacific Coast. Promotional materials, including press releases, order forms and reproducible art, were mailed to 700 sports writers and fishing editors throughout the country. In addition, the Tiburon Laboratory also sent out 14,500 printed order forms for the Guide for distribution--48% of these forms went to Sea Grant representatives in California, Washington, Oregon and Alaska; 22% to sportsmen's clubs and associations in California and Hawaii; 16% to California Department of Fish and Game offices; and 14% to NMFS Regional Offices and Laboratories in the Pacific states. This publicity effort was undertaken so that the results of the Anglers' Guide project will be available to as many Pacific anglers as possible.

PHYSIOLOGY INVESTIGATION

Larval Feeding in Striped Bass Investigated

Recently completed studies in the Striped Bass Task have allowed us to determine the daily energy consumption of larvae feeding on different live prey concentrations. To do this, estimates of the amount of prey eaten and the time to digest it in a 24-hour period were needed. Larvae at the ages of 8, 18 and 28 days after hatching were introduced to five concentrations (0.01, 0.10, 0.50, 1.00, 5.00 Artemia/ml) of live food. The average zooplankton density in the nursery grounds is estimated at approximately 0.10 zooplankters/ml. Under our experimental conditions larvae were found to feed most intensely in the daylight the first 10 hours after food introduction. Night feeding was limited to the younger larvae. As expected, larvae increased their feeding rates with age, size, and prey concentration. They digested their food within 1.5 to 5.5 hours. Larger fish in the higher food densities appeared to digest their food more quickly. The daily food rations were calculated from these data and expressed in numbers of Artemia ingested per day, their equivalent calories, and their equivalent numbers of natural prey zooplankters. Daily rations ranged from .4 to 324.1 zooplankters and they increased with age and prey concentration.

This information is being used to relate the amount of energy and/or natural food to different levels of survival and development. Further, we are in the process of estimating the daily ration of wild larvae based on data collected by the California Department of Fish and Game. Combined results from laboratory and field studies hopefully will provide better understanding of the relative contribution food ration makes to overall mortality during the larval stage.

Data Collected from Adult Striped Bass

Dr. Jeannette Whipple, Fishery Biologist, reported that analyses are continuing of subsamples from adult striped bass taken during spawning migration in the San Francisco Bay Delta, and from pre- and post-spawning fish collected by gill net at Tiburon Laboratory. Data from general autopsies are being coded for card-punching. Pete Benville, Supervisory Fishery Biologist, has begun analyses of petroleum hydrocarbons in ovaries and livers. Benville has also completed blood analyses of hematocrit, hemoglobin and erythrocyte fragility. Michael Bowers, Biological Technician, began chemical analyses of lipids in ovaries. Whipple and Brian Jarvis, Biological Technicians, are continuing differential counts and identification of erythrocytes and leucocytes. California Department of Fish and Game staff from Stockton, Bay-Delta Fishery Project, completed the scale-age analyses of the sample and the fecundity estimates of females and is forwarding the data to us.

Arrangements are being made with U.S. Fish and Wildlife Service for permission to collect a sample of "young-of-the-year" striped bass resulting from this year's spawning at the diversion facility at Tracy pumping plant in the south Delta. Some two-year-old fish will also be sampled if available.

Environmental data from other sources are being collected as appropriate for analyses, particularly of data on pollutants in effluents in the Carquinez Straits area. The striped bass migrate through this area during spawning.

Whipple and Mickey Eldridge, Supervisory Fishery Biologist, visited Dr. Howard Bern, an endocrinologist at U.C. Berkeley. The striped bass research was discussed with Dr. Bern and his assistant, Richard Nishioka, in terms of potential influence of environmental pollutants on steroid metabolism in striped bass resulting in alteration of normal sexual maturation and osmoregulation. Dr. Bern also discussed the research being done in his department on osmoregulation of fishes. A joint project to study endocrinological factors on striped bass during the spawning migration is being planned for next year.

The purpose of these studies is 1) to assess the potential influence of environmental factors on spawning adults and 2) to assess the influence of parental condition on the viability of gametes and 3) to elucidate factors which may relate to the annual striped bass "kill" in the Straits area.

Research on Petroleum Pollution Continues

Analyses of data resulting from research done under the OCSEAP project on "Transport, retention, and effects of the water-soluble fraction of Cook Inlet crude oil in experimental food chains" is continuing. All data have been coded, and some has been key-punched. Whipple, Tom Yocom and Ross Smart will proceed with covariance analyses of the data on completion of cardpunching.

Whipple completed a rewrite of the manuscript entitled "Introduction of monocyclic aromatics into sea water by an outboard engine" by Nina D. Hirsch, Pete Benville and Jeannette A. Whipple.

An updated listing of publications and manuscripts in preparation, resulting from petroleum and striped bass research in the Physiology program, was completed for information purposes.

Whipple, Nina Hirsch and Ross Smart met with Dr. Erwin Seibel, Director of the Tiburon Center for Environmental Studies, San Francisco State University, to discuss potential cooperative projects in pollution and estuarine research. Seibel was enthusiastic about this type of cooperation and expressed interest in the research projects proposed. The possibility of a joint seminar series was also discussed.

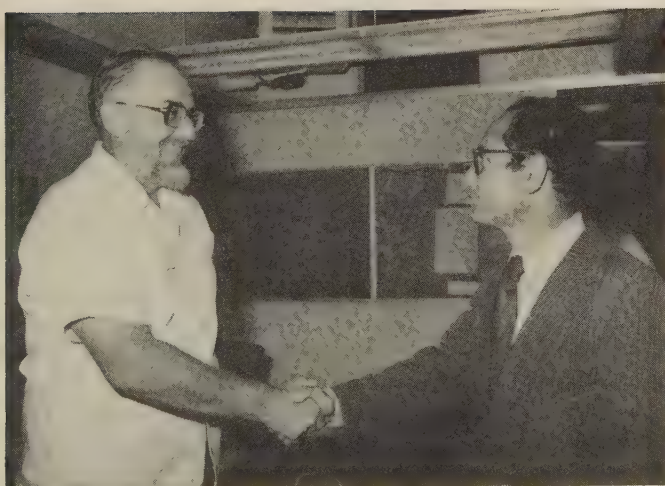
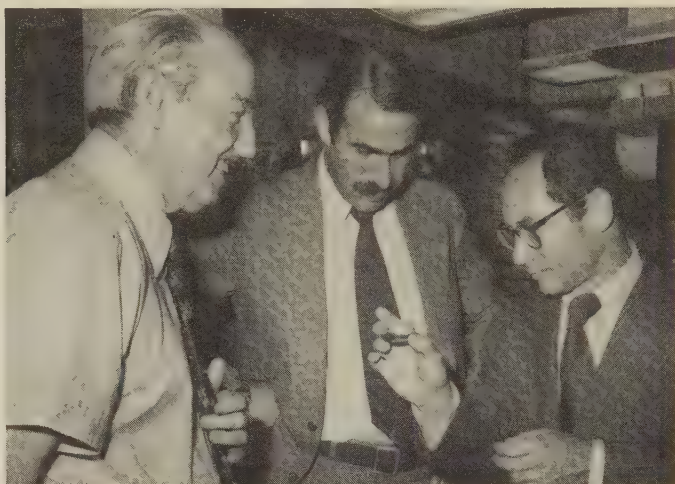
PUBLIC RELATIONS

NOAA Administrators Visit La Jolla Laboratory

Richard A. Frank, NOAA Administrator, and Terry Leitzell, NOAA Assistant Administrator for Fisheries, toured the SWFC La Jolla Laboratory and met with SWFC staff on September 28. The visit gave Leitzell and Frank an opportunity to acquaint themselves with research being carried on in California and to meet with Californians in the fishing industry.

Right:

Dr. Elbert Ahlstrom (right), Senior Scientist for the Coastal Fisheries Resources Division, showed cleared and stained flat-fish larva to Frank (left) and Eldon Greenberg (middle), NOAA General Counsel.



Left:

Dr. Paul Smith, Fishery Biologist (left), met with Frank and discussed the Anchovy Management Plan.

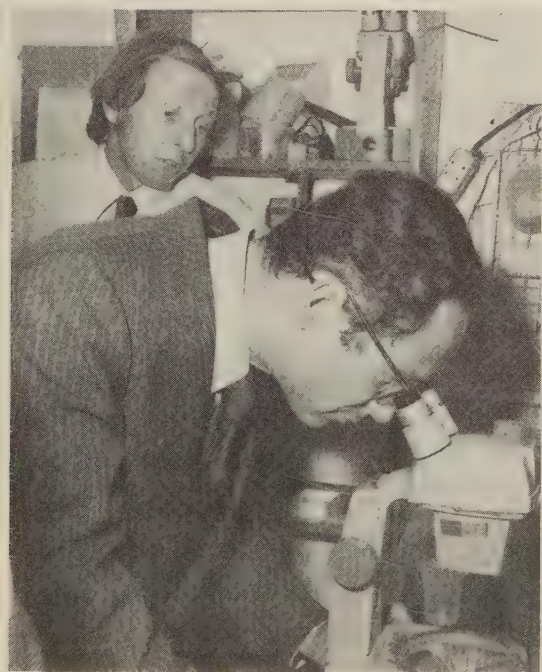
Right:

Dr. Reuben Lasker, Leader of the Coastal Fisheries Resources Division, welcomed Frank to the Center.



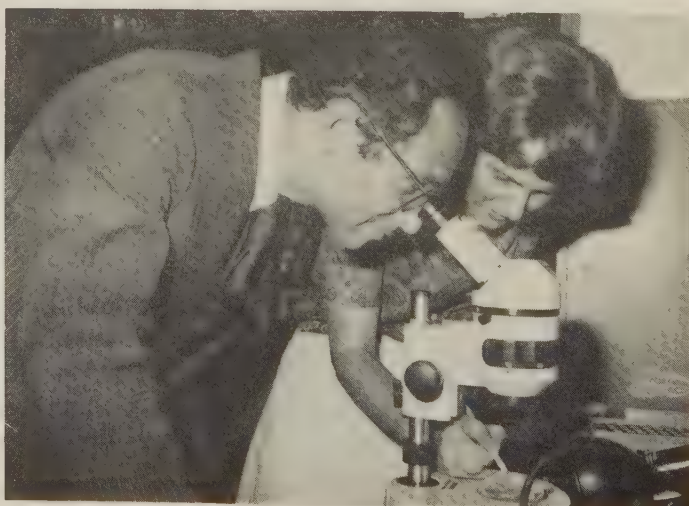
Left:

Frank examined larval anchovies assisted by Dr. John Hunter, leader of the Larval Fishes, Coastal East Pacific Program.



Right:

Biological Aid Susan D'Vincent showed Frank larval rockfish.



During their visit to San Diego, Frank and Leitzell toured a tuna boat, the Maria C. J. Captain Joe Jorge and his crew, who have one of the best records for saving the lives of porpoises in tuna fishing operations, demonstrated techniques of fishing that reduce porpoise mortality.

Right:

Administrator Frank (left) talked with August Felando, (middle) lawyer for the American Tunaboat Association, and Frank Alverson, (right) Vice President of Living Marine Resources.



Left:

Assistant Administrator Leitzell met Dr. William Fox, Leader of the Oceanic Fisheries Resources Division.

Leitzell presented several SWFC staffmembers with length of service awards. Three employees at the La Jolla Laboratory received pins for 15 years of federal service: Frances Tonsich, Secretary/Stenographer (pictured upper left), Dr. David Au, Operations Research Analyst, (pictured upper right), and Ruth Miller, Biological Laboratory Technician (pictured lower left). Dr. Laurence Eber, Oceanographer, received his 25-year pin (pictured lower right).



SEMINARS

Honolulu Laboratory

- September 7 - Dr. John Hunter, SWFC, La Jolla, spoke on "Feeding behavior and ecology of marine fish larvae," at the Honolulu Laboratory.

Tiburon Laboratory

- September 29 - Gary Grossman, a Ph.D. candidate from the ecology graduate group, Department of Wildlife and Fisheries, University of California, Davis, gave a talk on "Population Ecology of the Bay Goby in Morro Bay, California."

MEETINGS AND TRAVEL

- June 30 -
September 15 - Dr. G. Sakagawa of La Jolla Laboratory traveled to Honolulu to participate in the North Pacific Albacore Workshop.
- September 7-8 - R. Shomura, Director of the Honolulu Laboratory, and Center Director Barrett attended the Marine Mammal Commission meeting at the Reef Hotel. Subjects covered at the meeting included tuna-porpoise, humpback whales, and Hawaiian monk seals.
- 10-14 - J. Jennings of La Jolla Laboratory traveled to Honolulu to conduct tag loss rate experiments on wild Hawaiian spinner dolphins.
- 10-16 - Dr. M. Laurs of La Jolla Laboratory traveled to Honolulu to make a presentation at the North Pacific Albacore Workshop, and to meet with Honolulu Laboratory personnel.
- 10-17 - Paul N. Sund of PEG traveled to Seattle and Friday Harbor, Washington to do library work at NWAFC/MMD, discussed contracts at NASO, and met with Dr. Maurice Blackburn concerning co-authorship of a tuna-oceanography review paper.
- 11 - Shomura held a general staff meeting to discuss the Honolulu Laboratory reorganization to be effective on October 1.

- September 11 - A. MacCall, Dr. Stauffer, Dr. Huppert and others from La Jolla Laboratory attended a State-Federal meeting on cooperative bonito research.
- 11-13 - Dr. R. Lasker, leader of La Jolla Laboratory's Coastal Fisheries Resources Division, traveled to Washington, D.C. to attend an Ocean Sciences Board meeting.
- 11-15 - B. Remington of La Jolla Laboratory traveled to Washington, D.C. to participate in NMFS Financial Management System meetings.
- F. Kellenberger of La Jolla Laboratory traveled to Washington, D.C. to attend NMFS National Data Management Committee meeting.
- 12 - Jack Mackerel Advisory Panel met with Plan Development Team in Long Beach, California. Attendees from SWFC, La Jolla Laboratory included Huppert, MacCall and Stauffer.
- 12-15 - Dr. N. Bartoo of La Jolla Laboratory traveled to Honolulu to participate in the North Pacific Albacore workshop.
- 13 - MacCall attended Operation Research Branch meeting at CF&G, Menlo Park Laboratory.
- Huppert flew to Seattle as participant in Resource Review Board for contract on economics of multi-species fisheries.
- 13-14 - Shomura, Dr. Wetherall, and M. Yong participated in the North Pacific Albacore workshop.
- 13-15 - N. Abramson, Director of Tiburon Laboratory, traveled to Aberdeen, Washington to attend a meeting of the Pink Shrimp Management Plan Development Team.
- Dr. W. Fox, leader of La Jolla Laboratory's Oceanic Fisheries Resources Division, traveled to Miami to meet with scientists of SEFC attending ICCAT and to review their papers.
- Huppert traveled to Seattle to participate on Source Evaluation Board at NASO.

- September 17-23 - Shomura was on travel status in California. He met with Norman Abramson and Sus Kato at the Tiburon Laboratory; O.E. Kerns and R. Kunihiya, Bumble Bee Seafoods, San Francisco, to discuss our need for industry data to develop an economic profile for the billfish FMP; Mr. P. Buchan, Van Camp Seafoods, San Diego, to discuss our need for industry data for the billfish FMP; and G. Broadhead and others, Living Marine Resources, San Diego, to discuss our need for tuna catch statistics and our current contract with LMR. Shomura also attended the Center Management meeting and an ad hoc meeting called by the Southwest Region to discuss amendments to the billfish PMP.
- 18 - S. Covey of the La Jolla Laboratory traveled to Riverside, CA to attend a class at the University of California at Riverside in library data base systems.
- 18-22 - Dr. J. Hunter of the La Jolla Laboratory traveled to Honolulu to review milkfish program for the Agency for International Development at the Oceanic Institute Hawaii.
- A. Bakun of PEG traveled to San Francisco to attend a course, "Introduction to Supervision."
- 19 - K. Setbacken of PEG traveled to Monterey to confer with staff, PEG, and Mr. Paul Stevens, FNWC, concerning XBT probes.
- 19-22 - G. Seckel, Chief of PEG, traveled to La Jolla, CA to attend Center Management meeting.
- 20-21 - N. Abramson traveled to La Jolla to attend the Quarterly Center Management meeting.
- Huppert and McMillan of the La Jolla Laboratory attended annual meeting of Western Association for Valuation of Ecosystem in Issaquah, Washington.
- 20-22 - Ed Ueber, Economist at the Tiburon Laboratory, traveled to Issaquah, Washington to attend the annual Workshop of the Western Association for the Valuation of Ecosystems.
- 21 - M. Eldridge, Tiburon Laboratory, visited biologists of the California Department of Fish and Game at Stockton to discuss cooperative studies and the use of existing field data.

- September 26-27 - Dr. E. Hobson, Tiburon Laboratory, traveled to Chicago, Illinois to meet with Dr. Marlin Perkins to review the script of the episode they filmed in the Bahamas in August for the TV series Wild Kingdom.
- Ueber traveled to Portland for a meeting of the Dungeness Crab Management Plan Development Team.
- 26-28 - Dr. Taivo Laevastu, Northwest and Alaska Fisheries Center, met with Shomura on the 26th; on the 27th and 28th, led a discussion on an ecosystem modeling approach to the cooperative Northwestern Hawaiian Islands study at the Honolulu Laboratory conference room. Laevastu's participation was sponsored by University of Hawaii Sea Grant. In addition to Honolulu Laboratory personnel, scientists from U.S. Fish and Wildlife Service, Hawaii Division of Fish and Game, and University of Hawaii Sea Grant attended.
- 29 - Shomura attended the Western Pacific Regional Fishery Management Council's Open House at their new office at 1164 Bishop Street, Honolulu.

VISITORS

Honolulu Laboratory

- September 12 - Larry Johnson, University of Hawaii, visited H. Yuen to discuss tuna feeding behavior with respect to squid.
- 26 - Dr. Joseph Sylvester, St. Petersburg, Florida, who is involved in the sea turtle program in the Southeast Region, met with Shomura and Doyle Gates.
- 28 - Linda Paul met with Shomura and Drs. Dizon and Skillman to discuss her graduate degree research proposal on spiny lobsters.
- 28 - Drs. Yasuhiko Taki and Fujio Yasuda, Tokyo University of Fisheries, met with Shomura and Otsu. Taki and Yasuda were in Hawaii on a fact-finding mission relating juvenile bluefin tuna in various parts of the Pacific Ocean with the aim of increasing the bluefin tuna stocks.

- September 28 - Dr. Elvira O. Tan, Science Planning Officer,
Marine Science, National Science Board of the
Philippines, visited Shomura.
- 29 - David Nada, Pacific Tuna Development Foundation,
met with Shomura to discuss a tuna fishery
development plan.

La Jolla Laboratory

- September 5 - Ken Balcomb, Orca Survey, Friday Harbor, Washington.
- 7 - Carl Sandermann, Sandy Hook Laboratory, NMFS,
Highlands, New Jersey.
- 7 - Sandra Miller, Lockheed Center for Marine Research,
Carlsbad, California.
- 12 - Eugene A. Taylor, NOAA-NOS-PMC, Seattle, Washington.
- E.C.DeFabo, U.S. EPA, Washington, D.C.
- 13 - Robert Mason and Gary L. Bryant of the Bureau of
Reclamation, Boulder City, Nevada.
- 20 - Deputy Director of the Marine Fisheries Department
of Pakistan visited Dr. Ahlstrom and the staff of
the fish taxonomy group.
- P. Chapman from South Africa was referred by
Dr. R. Lasker to the Tiburon Laboratory for infor-
mation on the chemistry of oil pollution.
- 18 - Jorge Carranza, head of the Mexican Department
of Fisheries, visited the Center to attend the
meeting chaired by Dr. William Aron of NMFS,
Washington, D.C., on the endangered status of the
totuava.
- 22 - Dr. Enrique C. Lopez Veiga and J. Carlos Lopez of
the S. Cooperativa Armadores de Pesca of Spain,
and Pedro Macazaga and Adolfo Sueiro of the
Asociacion Nacional de Armadores de Buques
Congeladores de Pesca de Merluza, visited the
Center to discuss a potential fishery for squid.
- 26 - William V. Kielhorn, Aero Marine Surveys, Inc.,
Groton, CT.
- 27 - Robert Clark, Autonomous University, Ensenada, Mexico.

September 28 - Richard A. Frank, Eldon Greenberg, and Donald Fowler, NOAA, Washington, D.C.

Pacific Environmental Group

September 19 - Jim Johnson, State Department, Tokyo, Japan.
26-27 - Diane Stewart, Northwest Admin. Service Office, Seattle, Washington.
29 - William Woodworth, Water Management District, Monterey, California.

Tiburon Laboratory

September 1 - Martha L. Noble, Stanford University, Stanford, CA
- Fred Weiss, Shell Development Co., Houston, TX
5 - John Hayhurst, Mill Valley, CA
6 - Phillip Tesh, J.S. Trading Co., San Francisco, CA
13 - Keitaro Nomura, Macmarine, Ltd., San Francisco, CA
15 - Frank Dyer, SF Tyee Club, San Francisco, CA
20 - Piers Chapman, Sea Fisheries Branch, Department of Industries, Capetown, Republic of South Africa
- Dean Farrell, Sausalito, CA
- Frank Martell, DAr: Bohne & Son, San Francisco, CA
22 - James W. Bell, National Park Service, Philadelphia, PA
- Gary Rogers, Pt. Reyes, CA
28 - Robert Iverson, NMFS, Honolulu Laboratory, Honolulu, HI
29 - Mike Hearne, San Francisco State University, San Francisco, CA
- Margaret Bradbury, San Francisco State University, San Francisco, CA

TRAINING

- August 22 - Susan E. Smith, Fishery Biologist, Tiburon Laboratory.
Probability and Statistics, College of Marin.
- September 5 - Tina Echeverria, Fishery Biologist, Tiburon Laboratory.
Thesis Biology 898, San Francisco State University.
- 25-29 - Nancy K. Wiley, Computer Specialist and Robert D. Haught,
Ltjg., NOAA Corps, Tiburon Laboratory. Introductory
Cobol Programming, CSC, San Francisco.

PERSONNEL

- September 8 - Joan Woodward, Clerk-Steno, resignation - Tiburon Laboratory
- 12 - Brain Joyo, Biological Technician (Microbiology),
termination of temporary appointment - Honolulu Laboratory
- 15 - Reuben Lasker, change in title to Physiologist (Research
Administration) - La Jolla Laboratory
- 22 - Michael F. Johnson, Economist, termination of temporary
appointment - Honolulu Laboratory
- 28 - Francine E. Yagawa, Data Transcriber, termination of
temporary appointment - Honolulu Laboratory
- 29 - Dana Eng, Biological Aid, termination - Tiburon Laboratory
- Nancy Stapp, Biological Aid, termination - Tiburon Laboratory
- Candis Cooperrider, Biological Aid, termination -
Tiburon Laboratory



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